학교 내 칫솔질 환경 구축이 초등학교 고학년 아동의 구강건강 및 습관에 미치는 효과

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Changes in the oral health and tooth brushing habits of upper grade primary school children according to the composition of the tooth brushing environment of the school

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Objectives: This study aimed to provide basic data on the establishment of tooth brushing classrooms in elementary schools in South Korea. The basic data was gathered by investigating the upper-grade children's oral health and brushing habits according to the tooth brushing environment in their respective elementary schools.
Methods: A researcher compared the changes in dental caries and oral hygiene status with the Repeated Measure ANOVA in 137 elementary school students from three elementary schools.
Results: The results of oral hygiene status, the Gingivitis Index, the use of the tooth brushing facility, and the number of times students brushed their teeth each day were all compared for all three years of the study. Group A (classroom-type), with a classroom-style tooth brushing facility next to the cafeteria, showed more improvement than Groups B (new classroom-type) and C (corridor-type).
Conclusions: In order to make tooth brushing a habit, the tooth brushing facility should be constructed in the form of a classroom with good accessibility to the cafeteria. An active and practical form of education will need to be provided by the school teacher to help children form this habit.

Key Words: Child health, Oral health, Oral health education, Tooth brushing

Introduction

1. The need for research

Dental caries and periodontal disease are the two major oral diseases that the majority of Koreans suffer from. Dental caries, a major cause of tooth loss, is a disease that usually occurs and accumulates within two years of eruption and continues to develop. In addition, since periodontal disease begins to occur during the upper grades of primary school and increases during a person's lifetime, the oral health management ability of the primary school, the children in attendance, and the overall oral environment will influence lifetime habits for oral health[1,2]. Dental plaque is a representative cause of these oral diseases. The lack of tooth brushing after eating can cause dental plaque in the area where oral hygiene management has been neglected, leading to bacterial adherence, acid enamel corrosion, and

inflammation. This can result in dental caries and periodontal disease[3].The most basic and effective way to manage dental plaque is tooth brushing[4].

In the 2012 survey[5], 57.35% of those surveyed had permanent dentition caries at the age of 12. The DMFT Index (decayed, missing, or filled teeth) is at 1.8 for major industrialized countries, but has a world average of 1.67 (189 countries, as of 2011)[5]. According to the "Practice rate of tooth brushing after lunch" of school-aged Korean children, it is reported that from 7 to 12 years old, the rate decreases from 24.7% to 16.9%. This is more than two times the difference compared to deciduous dentition[5]. The primary school's tooth brushing facility should be designed to develop a tooth brushing habit for school-aged children. Providing a tooth brushing facility within the school's primary educational area for the children can lead to proper oral management and tooth brushing after lunch. It is a program that aims to improve the ability of students to manage their oral health[6]. Oral care for primary school children is a top priority among the national oral health care industry. The goal of Health Plan 2020 in Korea is to focus on oral health[7]. The target is to have 76.0% of primary schools install proper brushing equipment for children to encourage proper brushing habits leading to better oral health[7]. There is a plan to equip the tooth brushing facilities with the proper equipment, including toothbrushes and storage for them, but the actual discussion about the most effective installation structure to form tooth brushing habits has been excluded. In the related studies, there were studies on education through a children's tooth brushing education program[8], evaluation[9] of the short-term effects of the tooth brushing room, and effects on practicing tooth brushing[10]. However, the long-term follow-up of changes in habit in the same subject has been insufficient. This is a follow-up study[11] of the result of the "Tooth brushing room operation," the author's previous study. The result of the one-year tooth brushing room operation came from brushing, oral hygiene status, and oral health status. Based on this, we can provide concrete installation guidelines for the tooth brushing room installation project in Korea and basic data for providing effective structures to increase the practice rate of tooth brushing.

2. Purpose of study

In Korean primary schools, a child's oral health education is the role of the school nurse. Therefore, the school nurse's interest and role is the most important factor for the success of the primary school oral health project[12]. However, school nurses are not able to educate children on the proper tooth brushing technique because they lack the appropriate facilities and items, such as a wash basin. This is an obstacle in forming an actual tooth brushing habit in children. The purpose of this study was to develop the most effective tooth brushing environment to improve the intervention effect, such as the development of the oral health education program.

Materials and Methods

1. Research design

This study was a prospective study intended to analyze the long-term changes in the "Brushing practice rate, oral health index, and oral hygiene status" of higher grade elementary school students by establishing facilities where students could practice brushing after eating in the school cafeteria. This was a prospective study comparing the before and after of the experiment based on the "Non-equivalence experimental group, control group" (Fig. 1).

2. Subject of study

The study was conducted under identical conditions to examine the tooth brushing education at three elementary schools from June 21, 2010 to October 25, 2012. In addition, the results of the 2015 from December 15, to March 31 survey were analyzed again. These schools were similar in size and character to the ones that were selected for the project. Among them, the primary school in experimental Group A was the first school to have a prepared tooth brushing room in Korea. It was equipped with a classroom next to the cafeteria that had been operating continuously for five years before the study had started. The primary schools chosen for Control Group B and C each had a tooth brushing facility installed. The school in Control Group B had the same tooth brushing room type as the school in Group A, but the room in B was in a completely separate building from where the cafeteria was located. The tooth brushing facility at the school in Control Group C was located in a an open corridor. All three schools had the same tooth brushing education and materials, leading to the voluntary participation of the primary school children and the supervising school nurse. The subjects of the initial study included 236 examinees. The follow-up study was the same for all primary schools and excluded children who had transferred to other schools, those that did not participate in the oral examination, and those that already had a special oral environment. As a result, 143 children in the 4th Grade were examined. The children participated in the continual study for three years, up until the final year of the study which took place when they were in 6th Grade.
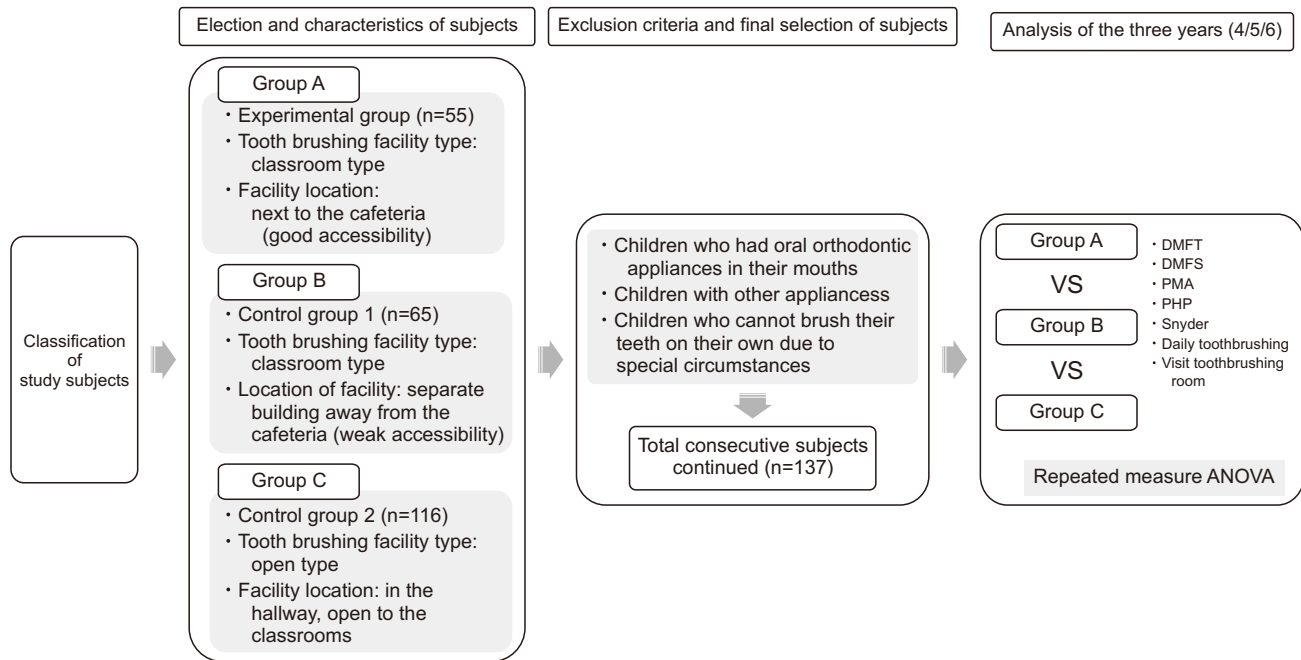
Fig. 1. Research procedure and research design.

3. Research tool

During each 12-month cycle of the oral health management process[13], the researcher visited each school once a year for three years. The researcher conducted individual interviews on the reality of oral health and surveyed tooth brushing practice through examination.

3.1. Oral examination

According to the WHO's criteria[14], the dentist examined the main factors affecting oral caries and oral caries with "flat gingiva with the light on the tip under natural light" through preliminary training. The Gingivitis Index and the Dental Plaque Index Test were also utilized in the oral hygiene status evaluation and were performed together.

3.2. Simplified PHP index

In order to identify residual dental plaque, the disclosing solution of the Patient Hygiene Performance Index (PHP index) was calculated using the simplified PHP Index (S-PHP index). The surface of the first molar of the maxillary left and right first molar, the lingual surface of the first molar of the mandibular first molar, the surface of the maxillary right middle incisor, and the surface of the mandibular left incisor were each classified into five sides using a disclosing solution (Sultan Chemists Inc., Englewood, NJ, USA). The sum of these values was calculated as 0 points for the lowest value and 30 points for the highest value. The lower the S-PHP Index score, the better the oral environment.

3.3. Gingival index (PMA index)

In order to evaluate gingivitis, the researcher divided it into three parts according to the position of the papillary papilla, marginal gingiva, and attached gingiva. Doing so examined the presence or absence of inflammation corresponding to the "P-M-A" area. The Gingivitis Index was calculated as 1 for inflammation and 0 for no inflammation. The lowest value was 0 and the highest value was 30[15]. The higher the PMA Index score, the more susceptible the person was to gingivitis.

3.4. Caries activity test

A dental plaque was made of the lower first molar teeth and placed in a separate incubation using a "Modified Snyder Test" that used dental cotton rolls with individually disinfected bars. The handle bar was then broken, the cap was covered, the number for each individual test label was marked, and the test pieces were incubated for 48 hours in a bacterial incubator maintained at 37℃[15]. For the result value, the acidogenicity was determined by the color change during incubation. The following lists the value of each color: blue represented 0 points and showed inactivity, green represented 1 point and showed a hardness activity, yellowish-green represented 2 points and showed moderate activity, and yellow represented 3 points and showed high activity. This indicated that the lowest value is 0 and the highest value is 3. The higher the score, the higher the dental caries activity.

3.5. Standardization survey method: oral healthcare behavior

To maintain consistency when analyzing the results, the subjects' tooth brushing practice rate, oral health index, and oral hygiene status survey were gathered through a series of 1:1 interviews. The results gathered from the questionnaires were then recorded. The following were items that were researched using the questionnaire: the number of times students brushed their teeth, how frequently the tooth brushing room was used, and how frequently the actual tooth brushing facility was used.

4. Research procedure

After receiving consent from the principal and the school nurse, an official school letter was sent out to each student's home to explain the study. Children with prior consent from their parents were selected for the study. The school nurse and dental hygienist explained proper tooth brushing rotations and conducted regular tooth brushing practice and oral health education. Primary school children were informed in advance so they would be aware of the tooth brushing facility. Each year, they regularly visualized oral microorganisms through phase contrast microscopy to enhance their motivation for tooth brushing education and practice. The tests were unified according to the standards set by the World Health Organization[14] as well as through the training and discussions of the dentist and dental hygienist. The time for the study was from 9:00 am to 12:00 pm under the same conditions for each school.

5. Data analysis

The homogeneity test between the experimental group, control group 1, and control group 2 was verified by comparing the DMFS (4th Grade), a representative index of oral health, through a one way ANOVA. Comparisons of the changes in dental caries status and oral hygiene status between the 4th, 5th, and 6th Graders were analyzed by the Repeated Measure ANOVA (post analysis: Scheffe). The significance level of the study was selected as $P<0.05$. All data was analyzed using SPSS Version 20.0 for Windows.

6. Ethical considerations

In order to protect the ethics of the subjects, the researchers received the approval (No. UC 2015-12-007) after the IRB deliberation by the institution's bioethics review committee. With the consent of the school principal and the school nurse of the schools participating in this research project, the subjects voluntarily participated after the purpose of the study was explained to them and notification was sent to the parents.

The children were told that they could withdraw their participation at any time during the survey, and that there was no disadvantage to participating in the study. In addition, we made it possible to contact us in case of any questions or problems. We also explained that the collected data would be anonymous and used only for this study, and that we ensured absolute confidentiality.

Results

1. Homogeneity test of subjects

The following was the lowest recorded measure of the DMFT Index (decayed, missing, filled teeth), represented by the oral health index, for each group: Group C with 1.79 ($\pm$2.02), Group B with 1.15 ($\pm$1.69), and Group A with 1.32 ($\pm$1.49) (P=0.185), respectively. There was no difference between the three groups (Table 1).

2. Change in the number of caries experience in teeth

the DMFT Index (decayed, missing, filled teeth) and DMFS Index (decayed, missing, filled tooth surface) were higher as age increased depending on the progressive nature. The DMFT Index was less than 2 in children in the 4th Grade. However, at the time, children in the 5th Grade in Group C showed 2.28 ($\pm$2.33), which is the highest among the three schools (P>0.05). In the 6th Grade, only Group A showed 3.00 in the DMFS Index. The other two schools changed to 3.03 and 3.83, respectively, but there was no statistically significant difference (P>0.05). Both the DMFT Index and the DMFS Index increased over time in all groups, showing as statistically significant (P<0.001). There was no difference in DMFT and DMFS between the groups (Table 2).

Table 1. Homogeneity test of general characteristics variables in pre-test (N=137)

Variable	Group A (n=22)		Group B (n=40)		Group C (n=75)		F	P
	Mean	SD	Mean	SD	Mean	SD		
DMFT	1.32	1.49	1.15	1.69	1.79	2.02	1.71	0.185

Values are presented as mean±standard deviation.
DMFT index: decayed, missing, filled teeth for permanent teeth index.

Table 2. Comparison of oral index according to time between groups (N=137)

Variables		After 1 year 4th		After 2 year 5th		After 3 year 6th			F	P
		Mean	SD	Mean	SD	Mean	SD			
DMFT	Group A	1.32	1.49	1.68	1.73	2.32	3.01	Time	21.693	0.000
	Group B	1.15	1.69	1.73	2.08	2.03	2.18	Group	1.444	0.240
	Group C	1.79	2.02	2.28	2.33	2.81	2.68	T×G	0.635	0.638
DMFS	Group A	1.73	2.35	2.14	2.57	3.00	3.82	Time	133.000	0.000
	Group B	1.50	2.11	2.53	3.21	3.03	3.60	Group	0.736	0.481
	Group C	2.20	2.63	2.85	3.47	3.83	3.99	T×G	268.000	0.544
PMA	Group A	2.68	1.52	2.18	2.74	3.45	3.43	Time	133.000	0.650
	Group B	4.05	3.90	6.08	4.86	4.13	3.32	Group	3.391	0.037
										Scheffe: B>A
	Group C	4.28	3.82	3.67	3.59	4.27	4.22	T×G	268.000	0.001
PHP	Group A	1.58	0.85	2.24	1.11	3.24	0.91	Time	150.385	0.000
	Group B	1.86	0.76	3.57	0.50	3.46	0.67	Group	8.699	0.000
										Scheffe: B,C>A
	Group C	2.17	0.83	3.15	1.00	3.47	0.66	T×G	7.878	0.000
Snyder	Group A	0.55	0.86	1.14	1.25	0.91	1.15	Time	1.793	0.169
	Group B	0.98	1.03	1.05	0.81	0.88	0.97	Group	1.324	0.269
	Group C	1.17	1.23	1.20	1.08	1.04	1.21	T×G	0.929	0.448
Daily toothbrushing	Group A	3.55	1.01	3.05	0.58	3.00	0.53	Time	10.822	0.000
	Group B	2.53	0.64	2.25	0.59	2.28	0.72	Group	23.841	0.000
										Scheffe: A>B,C
	Group C	2.59	1.04	2.51	0.76	2.07	0.64	T×G	2.050	0.088
Visit toothbrushing room	Group A	1.00	0.00	0.95	0.21	1.00	0.00	Time	133.000	0.000
	Group B	0.25	0.44	0.30	0.52	0.00	0.00	Group	156.316	0.000
										Scheffe: A>B,C
	Group C	0.19	0.39	0.29	0.46	0.00	0.00	T×G	268.000	0.004

Values are presented as mean±standard deviation.
T×G: Time×Group; A: Group A, classroom type; B: Group B, new classroom type; C: Group C, corridor type; DMFT index: decayed, missing, filled teeth for permanent teeth index; DMFS index: decayed, missing, filled tooth surface for permanent tooth index; PMA: papillary papilla, marginal gingiva,attached gingiva; PHP index: Simplified patient hygiene performance index; Caries activity test: Modified Snyder test; Daily toothbrushing: daily toothbrushing frequency; Visit toothbrushing room: visiting frequency for toothbrushing room.
*P<0.05.

3. Oral status index according to the patient hygiene performance index

Group A had the best dental plaque management status in the 4th, 5th, and 6th Grades. Group A was 1.58 (±0.85) after one year, 2.24 (±1.11) after two years, and 3.24 (±0.91) after three years. Group B was 1.86 (±0.76) after one year, 3.57 (±0.50) after two years, and 3.46 (P<0.001) after three years. Group C was 2.17 (±0.83) after one year, 3.15 (±1.00) after two years, and 3.47 (±0.66) after three years. As time continued, PHP rose in all of the groups and was statistically significant (P & lt; 0.001). The time difference and intergroup interaction (P<0.001) and the PHP difference between the groups were statistically significant (P<0.001, Scheffe: B, C>A) (Table 2).

4. Gingival index according to the PMA index

In PMA, Group A was 2.68 (±1.52) after one year, 2.18 (±2.74) after two years, and 3.45 (±3.43) after three years. Group B was 4.05 (±3.90) after one year, 6.08 (±4.86) after two

years, and 4.13 (±3.32) after three years. Group C was 4.28 (±3.82) after one year, 3.67 (±3.59) after two years, and 4.27 (±4.22) after three years. The PMA difference was not statistically significant in the groups as time elapsed (P=0.650). Time difference and intergroup interactions (P=0.001) and PMA difference between groups were statistically significant (P=0.037, Scheffe: B>A) (Table 2).

5. Caries activity test

The caries activity test was performed using the Modified Snyder Test. As a result, Group A was 0.55 (±0.86) after one year, 1.14 (±1.25) after two years, and 0.91 (±1.15) after three years. Group B was 0.98 (±1.03) after one year, 1.05 (±0.81) after two years, and 0.88 (±0.97) after three years. Group C was 1.17 (±1.23) after one year, 1.20 (±1.08) after two years, and 1.04 (±1.21) after three years. The Snyder difference was not statistically significant over time in any of the groups (P=0.169).

6. Frequency of tooth brushing

Group A showed that students were brushing their teeth more than three times a day. Both Groups B and C showed that students were brushing their teeth, on average, twice daily. This became statistically significant as time went by for all groups ($P<0.001$). There was no difference in the number of brushing days between groups ($P<0.001$, Scheffe: A>B, C) (Table 2).

7. Visiting the tooth brushing room

The number of times students used the tooth brushing room during the day at each school was recorded for the study. Group A used the facility once a day at 1.00 (±0.00) for both the 4th and 6th Graders. The exception for Group A was the 5th Graders at 0.95 (±0.21). Groups B and C were 0.25 (±0.44) and 0.19 (±0.39) for the 4th Grade, respectively, but the frequency of use varied and was statistically significant over time ($P<0.001$). Time difference and intergroup interactions ($P<0.001$) and difference between groups were all statistically significant ($P=0.004$, Scheffe: A>B, C) (Table 2).

Discussion

Although the school oral health business should be dedicated to the oral health workforce, it is a real difficulty to practice oral health in all schools because they lack an oral health workforce[16]. The government has been working to build tooth brushing rooms in schools since 2011 as a project to induce proper tooth brushing habits in school children[17]. The purpose of this study was to investigate the tooth brushing habits of higher grade elementary school students and the effects that tooth brushing had on oral health. However, in implementing the project, the budget and facilities of each school differ in terms of facility construction method, making it impossible to implement a standardized project. Also in this study, Also in this study, Group A had a tooth brushing facility in the cafeteria and a classroom immediately next to the cafeteria. Group B had a newly built tooth brushing facility in the form of a classroom, similar to that of Group A, but the cafeteria and building were separated, making it a somewhat inconvenient place for children to access. Group C had a tooth brushing facility with several water facilities opened in front of the staircase in the corridor where primary school children were moving. As a result of this circumstance, the author's short-term precedent study[9] was different in terms of project execution time. It was difficult to observe the differences according to each facility type and period of implementation in the long-term. The purpose of this study was to investigate the long-term effect of group tooth brushing on the habit changes of the children and the Oral Health Related Index. The DMFT Index and DMFS Index of Group B and C, which were newly established as the experimental group and the tertiary group, did not show any significant difference for three years. This period was seen as a result of the fact that the caries morbidity rate had reached the highest level due to the increased chance of consuming caries-inducing foods, such as candy and chocolate, beyond the control of the mother[8]. Dental plaque is attached to dental caries and periodontal disease. The Dental Plaque Index is an indicator of the oral hygiene management status as a measure of adhesion of pigmented surface bacteria shown through the use of dental coloring agents[18]. The relevant index, the "S-PHP Index," results were lowest in Group A from 4th-6th Grade. This meant that the management of oral hygiene, i.e. tooth brushing, was well managed. There was a significant difference between Group A and Groups B and C ($P<0.001$) in the 5th and 6th Grades. In the first study of Cho MJ[19], the Dental Plaque Index was significantly lower in the "tooth brushing room group" than in the "non-installation group." Park HS[20] and Kim SH et al.[21] have shown that the continuous operation of the tooth brushing room business contributes to lowering the Dental Plaque Index, resulting in a long-term operation of primary school children in Group A[17]. The primary school upper grades were confirmed to show the onset of gingivitis. The Gingivitis Index was the lowest in Group A with similar results to the Dental Plaque Index. There was a significant difference in the 5th Grade among all of the groups. The results of the Modified Snyder Test and the Caries Activity Test, conducted through intraoral bacteria, never showed any interactions between the groups for students during the 4th Grade. This suggests that a similar study[22] of elementary school students showed that the students were not able to manage their oral health by themselves. This also suggests that the dental caries disease was likely to occur during this time. In addition, the upper grades reported a negative impact on children's oral hygiene management, as children in this age frame tend to be particularly stressed at school. Therefore, education and instruction by the school nurse should lead to active participation[23-26]. When researching the number of times the tooth brushing room was being used each day, it was noted that Group A had a tooth brushing room in the 4th and 6th Grades. When looking at the daily use of the tooth brushing room, children in the 4th and 6th Grade in Group A used the tooth brushing classroom once a day. The children in both Groups B and C used the facility from Grades 4 to 5, but they did not use the facility at all during the 6th Grade. Children in Groups B and C were found to use the facility from 4th-5th Grade, but not in 6th

Grade. When looking at the average number of times children brushed their teeth each day, children in Group A practiced "Tooth brushing, on average, more than three times a day" for three years. This was a significant difference from "Groups B and C," as these groups practiced "Tooth brushing, on average, twice a day. These results were shown as the result of habit formation in children who had already been using the tooth brushing room starting in 1st Grade (or in 4th Grade in the case of Group A). The results of this study were similar to those of Jwa's previous study[11], which may be related to the use of the tooth brushing room or facility. The use of the tooth brushing room increased in the early stages after installation. In the 6th Grade, children in Groups B and C did not use the facility at all, indicating the social characteristics of the upper grades and the children's tendency to rely on groups[19]. In particular, the negative attitudes toward the school nurse and oral health were raised several times[10,25,26] in previous studies. It is thought that regular oral health professionals should provide better education to solve this problem. Previous studies have shown that a group that had experienced oral health education has a higher level of practice[27] than an inexperienced group, showing that repeated oral education increases the tooth brushing practice rate. Tooth brushing under the supervision of a teacher results in a lower[28] dental plaque Index. According to an opinion survey of teachers in charge of this work[10], most teachers stated that they need tooth brushing education for primary school children, regardless of whether or not they have a tooth brushing facility. Teachers in the area where the tooth brushing facility was installed complained that the main difficulties of this education were lack of time and an increase in work. It was also an important part of this study to maintain the school nurse for a long period of time so that children could practice, as well as equipping facilities in the same pattern as previous research results. First of all, I think it is important to focus on the education for tooth brushing practice rather than short-term education, and to manage and teach tooth brushing habits. In addition, the tooth brushing room should always be open and located close to the cafeteria so children can immediately use the facility after eating. Although it is a similar type of tooth brushing facility, the difference in the practice of oral health between Group A and Group B appeared to decrease when the approach to tooth brushing was not made easy for the children. Based on the results of this study and various previous studies, suggesting the form and guideline for preparing and financing an effective tooth brushing facility would increase the children's tooth brushing practice rate. Furthermore, it is thought that doing so will have good results in the formation of lifelong habits that can prevent dental caries and periodontal disease. The limitation of this study was the difficulty in securing the number of study subjects due to the decrease in the school-age population while pursuing the same children with similar characteristics in the same area. In addition, the limitation of the study was that more data could not be obtained due to the exclusion of children who had never used the tooth brushing facility during the three years of the study. The investigation of tooth brushing by individual methods with an emphasis only on the practice of tooth brushing of children is considered to be a factor in future research on this issue.

Conclusions

The purpose of this study was to provide basic data for the tooth brushing room installation project through an investigation of the oral health and tooth brushing habits in upper grade children according to the composition of the primary school tooth brushing environment. To compare the frequency of tooth brushing, tooth brushing facility usage, and the Oral Hygiene Management Index based on this study, children in Group A (classroom type), Group B (new classroom type), and Group C (corridor type) showed significant differences between the groups. This showed that long-term tooth brushing habituation and educational environment are important. As a limitation of this study, only differences by grade were investigated, and no differences were observed between males and females.In addition, a limitation of the study is that the first subjects were not continuously investigated as the subjects were investigated for three consecutive years. In addition, education should precede the use of these rooms to enhance the accessibility of children when equipped with a tooth brushing facility and to habituate tooth brushing through active intervention of the school nurse and teachers for the lower grades in the primary schools.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgements

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